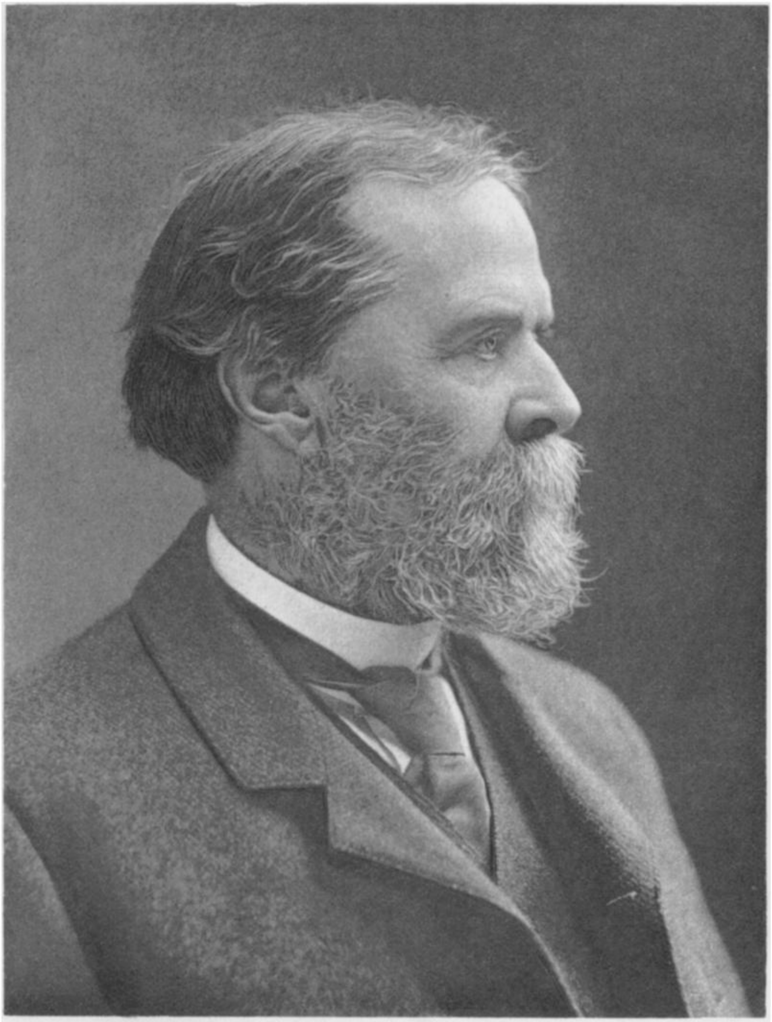
OLIVER WOLCOTT GIBBS, 1822–1908.[1]

(*Read May 20, 1910.*)

The father of Wolcott Gibbs, Col. George Gibbs, was a man of some wealth. Possessed of much talent, and of much culture, brilliant in conversation, of polished manners, and with a wide experience of men and life, he was one of the marked men of his day. His beautiful place at the northwest angle of Long Island, with its front on East River at one of its most picturesque points, was one of the landmarks of the river. This large mansion at Sunswick Farms, near Hellgate Ferry, was the seat of an elegant hospitality somewhat rare in this country at the time in question: within was a fine library and a collection of minerals, for Col. Gibbs was an enthusiastic mineralogist. He was for many years a vice-president of a geological society which met at New Haven, and his donations of valuable specimens to that as well as to other mineralogical societies were frequent. During travel in Europe, he purchased a large collection of minerals, which, in the years from 1810 to 1812, was arranged at New Haven. The use of this collection was freely given to Yale College up to the year 1825, when the college purchased it. Once meeting the elder Silliman in the steamer *Fulton*, on Long Island Sound, he suggested to the latter the establishment of the *American Journal of Science*, and urged it with a zeal which was successful. To the first and second volumes of the new journal, he contributed four notes and brief papers. The mineral Gibbsite was named in his honor, and his name is preserved in Rafinesque's curious "Manual of the Grape, etc." as that of a public benefactor who had, before 1825, established one of the earliest vineyards in the attempt to introduce European wine-grapes into this country; and it appears also in lists of agricultural competitions.

[1] The writer, not now having convenient access to a chemical library, has depended for facts upon Clarke's "Wolcott Gibbs Memorial Lecture" to an unusually large extent.



Wolcott Gibbs

Laura (Wolcott) Gibbs, the mother of Wolcott Gibbs, was a daughter of Oliver Wolcott, Secretary of the Treasury from 1795 to 1800, under Washington and Adams; afterwards justice of the United States Circuit Court, and, for the last eleven years of his life, governor of Connecticut. Her grandfather, Oliver Wolcott was brigadier general of Connecticut militia, member of the Continental Congress, and a signer of the Declaration of Independence, and lieutenant governor and governor of Connecticut. Her great-grandfather, Roger Wolcott, was major general of the army which captured Louisberg in 1745, being second in command at the siege, and was afterwards governor of the colony of Connecticut.

An older brother of Wolcott Gibbs was named George Gibbs. He early acquired a taste for natural history, so that, before he was twenty, he had made and mounted a collection of birds. After some years of travel, he studied law, and opened an office for the practice of the law in New York. He was for many years the librarian of the New York Historical Society; in 1846 he published "Memoirs of the Administrations of Washington and John Adams, edited from the papers of Oliver Wolcott, Secretary of the Treasury." He was appointed collector for Astoria in 1854. Residence here naturally gave him an opportunity for geological and for ethnologic and linguistic studies; in 1857, he accompanied an exploring expedition as botanist and geologist. Later, he served on a boundary commission. He edited, for the Smithsonian Institution, a large collection of documents relating to the ethnology and philology of certain Indian tribes.

Wolcott Gibbs was born in New York City, February 21, 1822. His parents gave him the name Oliver Wolcott, but he dropped the first name on entering adult life. His early days were spent mostly at Sunswick Farms. At the age of seven years, he was sent to a private school at Boston, where he was in the care of a maiden aunt. Some part of his vacations were spent at Newport, R. I., in the house of the distinguished Unitarian divine, William Ellery Channing. When he was about eleven years in age, his father died; his mother survived her husband by more than thirty-five years, and her strong character, and the great abilities which she had

inherited from the remarkable Connecticut family from which she was descended, furnished the lad with the guidance and the home influences suitable for his healthy development. At the age of twelve years, he returned to New York and prepared for college. In three years, he entered the freshman class of Columbia College, and was graduated in 1841, at the age of nineteen years. In the year before his graduation, he published the description of a new form of galvanic battery, in which carbon was used for the inactive plate; the young undergraduate publishing the discovery in the same year as Cooper and Schoenbein. The impulse towards such studies is to be found in the early life on his father's estate and in a father's example and other influence; but from the teaching of Renwick, then professor of physics and chemistry at Columbia College, a student like young Gibbs doubtless obtained much which was of value.

In the class of 1841, in which Wolcott Gibbs was graduated, there were at some time forty-nine men, of whom thirty-one took their bachelor's degree. Among these thirty-one, the most distinguished, after Wolcott Gibbs were: Duffield, senator for the Third Senatorial District of Michigan, brigadier general, United States Volunteers, 1863–1864, and superintendent of the United States Coast and Geodetic Survey, 1894–1898; and Emott, mayor of Poughkeepsie, justice of the Superior Court of New York, 1855–1863, and the judge of the Court of Appeals till his death in 1884. Among those who did not take the final degree was William H. Vanderbilt, who died in 1885.

After graduation, Wolcott Gibbs served for some months as assistant to Robert Hare, the inventor of the compound blowpipe, who was professor of chemistry in the Medical School of the University of Pennsylvania. After obtaining here an experience certain to be useful in fitting him for such a professorship, he entered the College of Physicians and Surgeons in New York, and received the degree of doctor of medicine in 1845. There is not much reason to suppose that Gibbs ever expected to practice medicine, for his next step shows that the study of chemistry had become the main purpose of his life. He went to Germany to secure such in-

struction in chemistry as was not then organized in this country. He first spent some months with Rammelsberg in Berlin, then studied for a year under Heinrich Rose, and then for some months under Liebig at Giessen. Lectures by Laurent, Dumas and Regnault marked the close of his days of travel and study, and in 1848, he returned to America. Among all these great teachers, it was Rose, whom he greatly admired, who seems most to have put his impress on Gibbs, and it may well be that from Rose came the preponderant inclination towards analytical and inorganic chemistry. But the young student who put himself under the instruction of the great leaders of organic chemistry, and of inorganic chemistry, and of theoretical chemistry and of physical chemistry, had already qualities from which were easily developed the breadth of view and of interest in very various kinds of research which always marked Gibbs.

He was soon appointed professor of chemistry in the New York Free Academy, now the College of the City of New York. The teaching required was elementary, and his activities accordingly overflowed in various channels. In the year 1851 he became associate editor of Silliman's *American Journal of Science,* to the establishment of which his father had contributed. To the succeeding forty-five volumes of this journal, Gibbs contributed 472 pages containing abstracts of 605 investigations on chemical and physical matters which had been published in Europe. The careful selection and the clear and accurate reports of these papers were a great service to American science. In 1852, Gibbs discovered a salt of xanthocobalt, a new cobaltamine; which led to important work, published in 1857, in collaboration with Genth. In 1861, he published the first of his papers on the analytical chemistry of the platinum metals. The considerable amount of the works, and especially the masterly ability shown in the paper on the cobalt bases, put Gibbs easily in the front rank of American chemists.

In 1863, Gibbs was appointed Rumford Professor of the Application of Science to the Useful Arts. He was expected to lecture on heat and light, and also to take charge of the chemical laboratory of the Lawrence Scientific School. As this was a position in which

little elementary instruction was required, the opportunity for usefulness to his students and to science generally were great. Association with such men as Louis Agassiz, the zoölogist, and Asa Gray, the botanist, and Jeffries Wyman, the comparative anatomist, and Benjamin Peirce, the mathematician, and Josiah Parsons Cooke, the chemist, together with their equals in other fields than scientific, made the position altogether delightful.

Dr. Gibbs remained in charge of the chemical laboratory of the Lawrence Scientific School for eight years. During this time his researches were naturally in great part directed to analytical methods, for he was training men who were to become chemists, some of whom were to gain a livelihood by being analytical chemists. The number of students in the laboratory was not large, some of these were qualified to assist Gibbs in his experimental researches. There was an assistant to take the burden of much routine work, and lectures on thermodynamics cost but little effort. The position was accordingly specially advantageous for one who would devote himself to chemical research.

Some one of the many distinguished chemists who were pupils of Gibbs in the Lawrence Scientific School could have spoken from personal knowledge of him as a teacher; but the choice of your president fell upon me, and it would only be some serious disability which would justify any American chemist in declining to voice the honor in which all of them hold Wolcott Gibbs. Since some expression of opinion and of feeling from those who came in close personal contact with him ought not to be omitted, it is fitting that the words in which one of the most distinguished of his pupils should be cited here. Clarke, chief chemist of the United States Geological Survey says:

> Most of the students had already gained some elementary knowledge of chemistry; their work began with the usual practice in analytical methods and chemical manipulations, and as the men showed capacity they were admitted to the confidence of their master and aided him in his investigations. This procedure may seem commonplace enough today, but in the years of which I speak it was new to American institutions and was looked upon doubtfully by some. . . . The real examinations under Gibbs were daily interviews, when he visited each student at his laboratory table and questioned him about his work. This, together with the reported analyses, gave the

teacher a clear conception of the true standing of each man. The fewness of the pupils was a distinct advantage, for all worked together in one room, beginners and research students often side by side. The result was that they learned much from one another, and there were many discussions among them over the chemical problems of the day. The men were taught to think for themselves, laying thereby a foundation for professional success which was pretty substantial. The course of instruction had no definite term of years prescribed for it, and graduation came whenever the individual had done the required amount of work, and submitted an acceptable original thesis. The final examination was usually oral, each man alone with his teacher, and was conducted in an easy conversational way which tended to establish the confidence of the candidate from the very beginning. In my own case, I remember that the questions covered a fairly broad range of chemical topics, and at the end of it, Dr. Gibbs drew me into a sort of discussion or argument with him over the then modern doctrine of valence. I now see that his purpose was not merely to ascertain what I had read on the subject, but what I really thought about it, if indeed I was entitled to think at all. Gibbs invariably treated his students, not as so many vessels into which knowledge was to be poured, but as reasonable beings, with definite purposes, to whom his help must be given. The research work in which the advanced students shared, and for which they received public credit, served to teach them that chemistry was a living and growing subject, and to train them in the art of solving unsolved problems.

What was there at all unusual in his teaching? Nothing, perhaps, from a modern point of view, but much that was new in America in the middle sixties. It was Gibbs's merit that he, more than any other one man, introduced into the United States the German conception of research as a means of chemical instruction, a conception which is now taken as a matter of course without thought of its origin. Gibbs worked with small resources and with no help from the outside; he was a reformer who never preached reform; his students rarely suspected that they were doing anything out of the ordinary; but they had the utmost confidence in their master, and took it for granted that his methods were sound. . . . The success of his students is perhaps the best monument to his memory.

In 1871, the chemical instruction in the Lawrence Scientific School was consolidated with that in Harvard College. This elicited vigorous protests from leading scientific journals, from scientific men, and from Professor Gibbs himself, but to no purpose. His duties henceforth were limited to his lectures on the spectroscope and on thermodynamics. He no longer had a laboratory in which to work, nor students, some of whom could assist in his researches. Contact with a great teacher was no longer a source of inspiration to students ready to profit by it. He himself had

more time for private research, but fewer facilities for it. Fortunately he had means enabling him to establish a small private laboratory, and to employ an assistant. It was in this laboratory, first at Cambridge and afterwards at Newport, that he carried out that one of all his researches which was the most important and elaborate and extensive.

The equipment of this laboratory was modest and very suitable for the work done in it. An ordinary kitchen stove served conveniently for the drying of precipitates in its oven, and the ignition of crucibles buried in the burning coal, and the heating or evaporation of liquids on its top. These processes were going on for much of the time during many years. There are kinds of work for which refined and elaborate apparatus barely accomplishes what is needful; if Gibbs had been occupied with work of this character, he would have provided it. There are not many things remaining which can be done with the iron spoon and gun-barrel which so well served Priestley; it happened that Gibbs, in his great work on the complex inorganic acids, was busy in a region very different from the determination of residuals which demands the utmost instrumental refinement, and his keen good sense suited the equipment to its purpose.

After the closing of the chemical laboratory of the Lawrence Scientific School, Dr. Gibbs lectured to small classes on the spectroscope and on thermodynamics till 1887, when he retired as professor emeritus. After this, he lived at Newport, where he had before spent summer vacations. His private laboratory was reëstablished here, and he continued his researches a long as health and strength sufficed. Some of his hours of recreation were spent in his flower garden, and his roses were much admired. He passed away on the ninth of December, 1908, at the age of eighty-six years nine and a half months. His wife, whose name was Josephine Mauran, died several years earlier, leaving no children.

It remains to speak briefly of Gibbs's scientific work. Fitly to describe it, even to an audience of chemists, would take more time than our traditions in the American Philosophical Society allow, so it is the esteem in which the work is held rather than the details of the work which will occupy us.

The infinite variety of careers for which variety of native powers and accidental advantages and opportunity open before us commonly involves at the beginning of active life a period of effort which is more or less tentative. Gibbs was no exception to this rule, but the period of tentative effort was brief, including, perhaps, only the first half dozen of his scientific papers. It is worthy of note that these show a somewhat wide range of interest and capacity.

His first scientific paper, published while in the junior class of Columbia College, was entitled "Description of a New Form of Magneto-Electric Machine, and an Account of a Carbon Battery of Considerable Energy." While a student in the medical college, he published a discussion of the theory of compund salt radicals. While a student in Germany, he published several mineral analyses. Just before becoming professor of chemistry in the New York City Free Academy, he showed that color changes produced by heat are in the direction of the less refrangible end of the spectrum. In 1852, he published the first of his papers on analytical methods. In 1853, he prepared an arsenical derivative of valeric acid. None of this work was of commanding importance, but it was of good quality, and it well illustrates Gibbs's knowledge of, and power of interesting himself in, somewhat widely varied departments of his chosen science.

The work to be mentioned next was worthy of the powers of any chemist in the world, and gave to him an established reputation and an honorable place among the leaders of chemistry. During the years to which allusion has just been made, he had been at work on a new cobaltamine, and, in 1856, he published a great research which commanded general recognition of the abilities of a master. A salt of the first known of the cobaltamines had been prepared by Gmelin in the year in which Gibbs was born, but it was some time before its true nature was understood. In 1847, Genth, then a student in Germany, prepared other related compounds and was the first rightly to understand their composition. Two French chemists working independently came to conclusions like those of Genth; he had established the composition of the two cobaltamines now called

luteocobalt and roseocobalt. Gibbs in 1852 established the composition of a third and new cobaltamine now called xanthocobalt, and the two American chemists naturally were led to work in concert. In 1856 they published their celebrated memoir, describing no less than 35 salts of these three cobaltamines, together with some of those of a fourth called purpureocobalt. They gave adequate analyses of these salts, together with crystallographic measurements, by J. D. Dana, of eleven of them. Purpureocobalt was then first distinguished from roseocobalt, though the conception then attained of the precise nature of the difference was not final. Gibbs attempted a discussion of the constitution of these bases, but prematurely. Adequate theories of structure were yet to be developed; when such development came, the facts established by Gibbs and Genth formed a solid foundation for the brilliant superstructure. Eleven years after this paper, Gibbs himself made an attempt to establish the theory of the structure of these amines. The conception utilized by Gibbs was also utilized two years later by one of the leaders in the establishment of the doctrines of structural chemistry; these views have now given way to other views which harmonize better with a wider range of facts; but the discussion of tentative possible explanations of facts is one of the steps by which the truth is finally discovered. Gibbs utilized his hypothesis of the structure of the cobaltamines in further papers in 1876 and 1877, in which he described many more salts, some of these being salts of a fifth amine called croceocobalt. The whole was a great piece of valuable and most fruitful work, carried on with extraordinary ability and success.

The work on the platinum metals, published from 1861 to 1864, related mainly to analytical methods. In 1871, he published a brief note on a remarkable compound of iridium, and in 1881, he described a new basic compound of osmium. But these researches had to be discontinued for lack of suitable facilities.

Gibbs was a man fertile in varied suggestions; in many a conversation he would lavish freely material almost sufficient for the working capital of a teacher who taught largely by inspiring and directing research. It was natural, therefore, that besides the great

work on the cobalt bases and another greater work yet to be mentioned, he should publish many papers of less extent. From the hand of such a master, these papers are valuable and important. Many relate to analytical methods; many relate to the analytical methods of the platinum metals, or to new compounds of the platinum metals. These papers are numerous; most of them are too technical for presentation here, but one of them is especially worthy to be mentioned and to be mentioned in this city. The electrolytic determination of copper was first published from the laboratory of the Lawrence Scientific School and the whole field of electro-chemical analysis, nowhere cultivated more successfully than in Philadelphia, was opened by Gibbs. In collaboration with E. R. Taylor, he devised filters composed of insoluble powders like glass and sand; then Munroe, another student, invented porous porcelain cones for filtration, and Gooch, an assistant of Gibbs, invented perforated crucibles with filters composed of layers of asbestos fibre made into a felt, in place of which we now often use spongy platinum. So the use of filters which do not change weight on ignition and which do not require us to heat reducible substances in contact with carbon, is due to Gibbs.

The most remarkable work of Gibbs is contained in his series of researches on the complex inorganic acids, whose publication began in 1877 and was continued till after 1890. Some complex inorganic acids were already well known; for instance, phosphomolybdates are in common use. But, in his first paper, Gibbs showed that, far from being exceptional compounds, they were members of an extensive class; that the formation of complex acids was characteristic of tungstates and molybdates to an extraordinary degree; and that the possible number of such compounds was vast. After this preliminary announcement, Gibbs determined the true composition of the sodium tungstates. Then he prepared phosphotungstates and phosphomolybdates, and similar compounds with arsenic in place of phosphorus. From this beginning, the work developed in directions which cannot be well described except to an audience of chemists; taking in all the degrees of oxidation of phosphorus, with all the known variations in the amount of replaceable hydrogen

in its numerous acids. Then were described complex acids with not two but three acid radicals in the complex, like that of the stannophosphotungstates. Next, other elements like platinum, selenium, tellurium, cerium, uranium, were drawn into like complex acids. On salt, phosphovanadiovanadicotungstate of barium, $60WO_3$, $3P_2O_5$, V_2O_5, VO_2, $18BaO$, $150H_2O$, had an atomic weight of 20,066 and a complication the interpretation of which seems almost incredibly difficult. Salts of over fifty such complex acids were described, and all this immense volume of work was accomplished in a small private laboratory with only one assistant.

In his address as president of the American Association for the Advancement of Science in 1898, Gibbs spoke on the complex inorganic acids. That the views then presented were final was not to be expected. Even to establish a simple matter like the composition of water, expressed in three characters, required, if we may agree with Kopp, no less than the joint efforts of three men. In the case which we have to consider, one man was working alone in a wilderness to be compared, both for extent and for complexity, not to a simple problem in inorganic chemistry, but to some great section of organic chemistry. But though working alone, he mapped out the wilderness so that he who will may now survey it at his ease. We are now in possession of methods which would have been of great service in this reconnoissance, had they been developed early enough. The cryoscopic or the ebullioscopic method of determining molecular weights would have helped to ascertain whether a given body was a compound of a basic radical with a single complex acid radical or with two simple acid radicals. Electrical methods might have assisted in ascertaining the composition of a complex ion. But these methods by means of which physical chemistry has made so great conquests were not ready to be used when Gibbs worked, and, accordingly, his survey does not include some facts and some conclusions which they might establish. So Newton had no spectroscope to use. But that the work of Gibbs was less valuable for this reason, few chemists would be willing to admit. He put before us a great and difficult problem and he did, towards its solution, more than almost any other man could have done.

It has been indicated that Gibbs had a wide range of insight and interest. He did no considerable work in organic chemistry, but he did not entirely neglect it. Lecturing as he did upon heat and light, and writing as he did for twenty-three years the abstracts of physical researches which appeared in the *American Journal of Science,* he had a knowledge of and an interest in, physical subjects which was expressed in several papers on optical matters. Serious work on atomic weights was carried on in his laboratory and under his direction, where three important determinations were made; he also devised a method of determining some atomic weights which had before been rather difficult to obtain. He published this method after he was seventy years of age, and the method has since been applied by others with good success. Processes requiring refinement and consummate accuracy were attractive to him, as well as some in which refinement and final accuracy are to be attained by some future generation. In an important study of the physiological effects of isomeric organic compounds on animals, he utilized his early medical training.

All Gibbs's activities were actuated by very high ideals. He was little known by the public at large, even by the best part of the public, but was greatly honored among scientific men. He was one of the founders and original members of the National Academy of Sciences and for some years was its president. He was president of the American Association for the Advancement of Science in 1897–1898. He was an honorary member of the three great chemical societies of the world and of the Prussian Academy of Science, and several universities gave him honorary degrees. He was a devoted scholar, glad to give his best efforts to the world, highly valuing unsought approval, and never seeking other reward. He was during the civil war, for several years an earnest and active member of the Sanitary Commission. It was he who first suggested that the ideas on which the Sanitary Commission was founded ought to take the form of a club, and it was at a meeting in his house that the Union League Club was established.

In the words of Clarke:

Gibbs was a man of striking personality, tall, erect and dignified. As with most men of positive character, he had strong likes and dislikes, but

the latter never assumed unworthy form. To his friends he was warmly devoted, and always ready to help them in their work with manifold suggestions. His breadth of mind is indicated by the range of his researches, and his liberality by the way in which he encouraged his students to develop his ideas. More than one important investigation was based upon hints received from him, and was carried out under his supervision, to appear later under another name. Gibbs never absorbed the credit due even in part to others, nor failed to recognize the merits of his assistants in the fullest way. Had he been more selfish, his list of publications would have been lengthened; but his sense of justice was most keen, and therefore he held the esteem and confidence of his co-workers. No man, not even among his opponents, for such there were, could ever accuse him of unfairness. He deserved all honor, and his name will long live in the history of that science to which his life was given.

EDWARD W. MORLEY.